Jackson does not appear to favour their claims to rank among the higher group. The vexed question of the homologies of the Arthropod appendages is treated fully The antennules of Crustacea are doubtfully classed as true appendages, while the Crustacean antennæ, with the cheliceræ of Arachnida are regarded as post-oral appendages which have become pre-oral by shifting forwards. The antennæ of Myriapods and Insects are ruled out, "as being apparently processes of the procephalic lobes;" while the suggestion that the telson represents a region rather than a somite will meet with very general approval.

Brauer's classification of Insects is adopted, with some slight modifications, and is given in considerable detail. The leeches are treated with caution as an isolated group, and no suggestion is made of their possible affinities with Turbellaria.

Among the lower groups the Cœlenterata are dealt with very thoroughly. The possibility of near kinship between the Acraspedote Medusæ and the Anthozoa that has found favour of late with Götte and others is mentioned, but rejected. The Protozoa also receive very liberal and thorough treatment, more than a hundred pages being devoted to them. As regards classification three main divisions are adopted: the Acinetaria, Ciliata and Mastigophora are classed together as Plegepoda, a group equivalent to the Stomatophorous Corticata of Lankester, and for which the old term Infusoria might conveniently be used. The remaining divisions are the Endoparasita or Sporozoa, and the Rhizopoda, the latter group being equivalent to Lankester's Gymnomyxa.

Mr. Jackson is a singularly modest writer, and seldom allows his own hand to be seen; a note on the blood-vessels of the earthworm, in which he questions the existence of the so-called subintestinal vessel, is of considerable interest; and throughout the volume there is abundant evidence of intimate practical acquaintance with the groups he describes so well.

The importance, even for the junior student, of direct reference to original papers was, as we have noticed above, one of the points on which Prof. Rolleston insisted most strongly. In this respect Mr. Jackson has afforded assistance of a singularly efficient character. Possessed of a most unusually accurate and extensive acquaintance with the zoological literature of all countries, Mr. Jackson has given the full benefit of his knowledge to readers of his book. Every page teems with evidence of the most diligent research amongst authorities, and none but a specialist in each group can estimate rightly the enormous amount of labour that its preparation must have cost him. Only less admirable is the restraint which has enabled him to refrain from burdening the book with an undue number of references, while those that are given have been selected with the utmost care, and arranged in such way as to afford the student aid of a kind hitherto denied him. "The method I have adopted," says Mr. Jackson, "is to cite the most important and recent authorities, which, when consulted, will in most cases give the names of all other accounts worth reading, so as to form a really very complete index to the state of present knowledge." It is this "index" which constitutes the characteristic feature of the new edition; and in the care and thoroughness with which he has compiled it, Mr. Jackson has conferred an inestimable boon on zoologists, and has rendered his work indispensable to teachers and students alike.

The earlier edition of "Forms of Animal Life" was marked by a certain singularity, at times almost grotesqueness, of diction, which interfered to some extent with the popularity of the book; we are glad to observe that care has been taken to remove this blemish, though an occasional tendency to reversion may be noticed in such statements as that "the anterior prostate is divaricable into two lobes," or that a given figure is "one-half less than natural size."

It would be better, too, if zoologists could completely emancipate themselves from the traditions of human anatomy, and cease to speak of the anterior part of a rabbit as the "upper half," or to use such terms as "vena cava descendens." "Uro-genital," too, which threatens to establish itself permanently, should not be used for urino-genital; and the term "pseud-hæmal" is objectionable, and, as applied to the vascular system of an earthworm, meaningless.

However, these are but small points; and in concluding we acknowledge in the fullest degree the singularly painstaking and conscientious manner in which Mr. Jackson has fulfilled his task, and the signal service he has thereby rendered to zoologists. "Forms of Animal Life" is a unique book; none but Prof. Rolleston could have written it; and probably there is no one who could have retained and developed more successfully than Mr. Jackson has done the exactness and thoroughness to which Prof. Huxley long ago alluded as its special charm.

A M. M.

THE CARDINAL NUMBERS.

The Cardinal Numbers, with an Introductory Chapter on Numbers Generally. By Manley Hopkins. London: Sampson Low, 1887.)

UNLIKE Hudibras, who could, as we are told, "extract numbers out of matter," Mr. Hopkins proposes in the essay before us to extract matter from numbers, or, as he says in the preface, "to show that every-day things—numbers being one of them—possess in themselves materials worth investigation, and connections with other subjects of thought and study." Our author does not attempt any systematic investigation of the properties of numbers: to do so would far transcend the modest limits to which he confines himself. He prefers to consider numbers in their relation to such subjects as religion, music, poetry, mythology, and superstition. Some purely numerical facts are, however, given, which either are, or else ought to be, found in every text-book of arithmetic—for instance, the rules (given on p. 75, at the beginning of the appendix) for determining when a number is divisible by any of the first twelve numbers, 7 only excepted. The cardinal numbers from 1 to 10 inclusive are treated separately in ten distinct chapters. These, with the introductory chapter and an appendix, the principal portion of which is taken up with magic squares, form the whole of the work.

The nature of our author's remarks will be best seen by making a few quotations. Thus in the chapter on Number One, after speaking of the unity of the Godhead and the oneness of self, he goes on to say:—

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> "Geography and natural history abound in words which express the separateness of an object, its isolation, its *one-liness*. Similar to the number 1, and to the pronoun I, there are found in different languages and dialects referring to local separation, the words *i*, *hi*, *ey*, *eye*, *egg* (and here think of the Latin *ego* and the Greek ἐγώ), *eyot*, *ait*, *inch*, *innis*, *île*, *isle*, *inver*, *insula*, *isola*, *isla*; and connote some of these with the animal *eye* and *egg*, having a similar separation as an island in geography. All the latter have the same meaning, and express a portion of land segregated, cut off from other land and surrounded by water—oneness."

With the above we may compare Shakespeare's use of the word *eye* in the passage—"The ground, indeed, is tawny. With an eye of green in 't" ("Tempest," Act II., sc. 1).

Respecting the celebrated *twos* in profane myth and history, we read in the next chapter:—

> "Prominent among these are Romulus and Remus; Brutus and Cassius; and in Irish legend Eber and Airem; concerning whom we are informed that Eber was slain by his brother Airem. He was the hero of the Ivernians, the ancient non-Celtic inhabitants of Ireland. Airem was the ancestor of the Celts who conquered the country."

The Hibbert Lecture, May 1886, is referred to in a footnote as the source from which this Irish version of the story of Romulus and Remus was taken. It is new to us, and will probably be so to most of our readers.

In the chapter on Number Three we are told the origin of the heraldic *fleur de lys*:—

> "It was the device of *three* fishes tied together with a ribbon, which formed the *fleur de luce*—*luce* being the name of the fish; but which was afterwards transfigured into the more elegant emblem of the *fleur de lys*, the flower of the iris, taking the place of the fish, its *three* petals still presenting a trine."

It will be remembered that Justice Shallow, in the opening scene of the "Merry Wives of Windsor," speaking of "the dozen white luces" in his coat, remarks that "the luce is the fresh fish."

To the noble army of circle-squarers we leave the task of refuting the following argument; merely remarking that it may with equal facility be used to disprove the quadrature of the parabola, which has been believed in by all orthodox mathematicians since the time of Archimedes:—

> "In a quadrangle, the space may be divided into the minutest squares, leaving no space undivided; but in a circle, every square applied to its periphery will always leave an angular space; and however far the process of smaller angles may be carried, an ultimate undivided space will remain."

Apparently our author is not quite satisfied with this; for in the next paragraph (on p. 47) he proves, in another manner, that the circle cannot be squared. In both proofs, for the words "a circle" we may substitute "any curve, including the parabola," without thereby affecting the argument.

We have never heard of Montrecla, to whom we are referred for an account of attempts to square the circle; but possibly Montucla is meant, who in 1754 published a "History of Researches relating to the Quadrature of the Circle," a second edition of which (by Lacroix) appeared in 1831. This conjecture is strengthened by the fact that our author's list of the principal calculators of π ends with Vega (born in 1754 and murdered in 1802), who obtained its value to 140 decimal places, making no mention of Rutherford and Shanks, who in more recent times pushed on the calculation to 500 and 707 places respectively.

From Chapter VII., which treats of a variety of subjects, including among them "the number of the beast" and the fine distinction between *six* and *half-a-dozen*, we select for comment the following sentence:—

> "Six, also, is the least number of the *points of fixature*; so that a body cannot under all circumstances be immovable unless secured (or resisted) at six points."

Having only common-sense to guide us, and being unable to divine what train of reasoning could have led the author to the above conclusion, we should imagine that whenever any two points, A, B, of a body are fixed every other point in the straight line AB is also fixed, so that the body can only rotate round the line AB. Consequently if any third point (not in the straight line AB) is also fixed the body is immovable. Do the words "under all circumstances" imply that the body is immovable even when all *six* of our author's "points of fixature" are in the same straight line? If not, we are at a loss to know what they mean.

The appendix contains among other things a method of filling up magic squares which is said to have been communicated by a Russian mathematician to Prof. Sylvester and by him to a friend of the author. As some portions of the Russian Empire are not very far distant geographically from the land of the Chaldæans, this tradition may have had its origin among the magicians, astrologers, Chaldæans, and soothsayers of the Court of Nebuchadnezzar, to whom magic squares were doubtless well known. We hope Mr. Hopkins will be able to trace it to its source, even though it would take some time to do so, and the appearance of a second edition of "The Cardinal Numbers" might thereby be delayed. The public need not be impatient, for they can in the meantime allay their curiosity concerning the properties of magic squares by a perusal of the "Mathematical Recreations" of Ozanam and a host of more modern writers.

OUR BOOK SHELF.

The Romance of Mathematics. Being the Original Researches of a Lady Professor of Girtham College in Polemical Science, with some Account of the Social Properties of a Conic; Equations to Brain-Waves; Social Forces; and the Laws of Political Motion. By P. Hampson, M.A., Oriel College, Oxford. (London: Elliot Stock, 1886.)

OUR first acquaintance with the title, which we have copied in full, was limited to its four opening words. These suggested various ways in which the subject might be treated; we had no idea that the task before us was to examine and report upon a somewhat mild *jeu d'esprit*.

The editor, who poses as a Cambridge student and quondam pupil of the Girtham Professor, and subsequently as her husband, discovers, in a well-worn desk, certain lectures, essays, and other matter. In his introduction he says it is not his intention to disclose how he came into possession of the papers; in the closing pages he is caught in his work of reading and transcribing, and "at length we gained our point, and obtained the full sanction of the late Lady Professor of Girtham College to publish her papers." "Thus her obedient pupil is enabled to repay his late instructress for all her kindness to

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